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Diagnostic accuracy of CAPD and SOS-PD in detecting delirium infants: A systematic review

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Abstract

Background: Delirium in infants admitted to the neonatal intensive care unit (NICU) is a critical but often underrecognized condition. The Cornell assessment of pediatric delirium (CAPD) and Sophia observation withdrawal symptoms–pediatric delirium (SOS-PD) are used for early detection, yet their diagnostic accuracy in infants remains unclear.

Purpose: To evaluate the sensitivity, specificity, and validity of CAPD and SOS-PD in detecting delirium among infants.

Method: A systematic review was conducted on observational diagnostic validation studies published in the last ten years involving infants. Searches were performed in PubMed, ProQuest, ScienceDirect, SAGE Journal, Taylor & Francis, Cochrane, and Clinical Key. Risk of bias was assessed using QUADAS-2, and data were synthesized narratively.

Results: Seven studies met the inclusion criteria. CAPD showed sensitivity of up to 94.1% and specificity of 79.2%, while SOS-PD demonstrated sensitivity of 92.3% and specificity of 96.5%. A major challenge was distinguishing delirium from iatrogenic withdrawal syndrome (IWS).

Conclusion: CAPD and SOS-PD are valid and reliable tools for delirium screening in NICU infants, supporting early detection and improving patient safety and quality of care.

Keywords: CAPD; Delirium; Diagnostic Accuracy; NICU; SOS-PD.

INTRODUCTION

Delirium in infants admitted to the Neonatal Intensive Care Unit (NICU) has increasingly been recognized as a significant clinical complication; a prevalence study reported that approximately 22.4% of NICU infants were identified as experiencing delirium (Siegel, Groves, Silver, Hojsak, Lim, & Traube, 2021). Previous studies have also shown that the prevalence of delirium among critically ill pediatric populations varies widely, ranging from 7% to over 60%, depending on the study population and the diagnostic tool employed (de Almeida, Kawai, Prata-Barbosa, & de Castro, 2025). Child mortality remains a critical global concern. The rate of preterm births continues to rise worldwide, with approximately 13.4 million infants born prematurely in 2020, before

completing 37 weeks of gestation (World Health Organization, 2023). In 2023, the global neonatal mortality rate was 17 per 1,000 live births, corresponding to approximately 2.3 million infants who died within the first month of life. This equates to approximately 6,300 neonatal deaths every day (United Nations Children's Fund, 2025). Therefore, further efforts are urgently needed to reduce infant mortality, particularly among preterm infants, through the provision of intensive and comprehensive care.

Delirium is a neurocognitive disorder characterized by disturbances in attention and consciousness levels (Adams & Sprecher, 2022). Delirium in NICU infants often goes unrecognized, even though it can occur in those with severe and

critical health conditions. To date, no diagnostic tool has been specifically developed to assess delirium in infants within the NICU setting (Tarrell, Giles, Smith, Traube, & Watt, 2024). Therefore, systematic delirium screening using validated instruments is an essential component of evidence-based nursing practice in the NICU. At present, the occurrence of delirium in the infant population still lacks the development of instruments specifically tailored for this age group, making it challenging to accurately describe the incidence and risk factors of delirium among these patients (Bergus, Patterson, Castellanos, Bourgeois, MacDonald, Mallampalli, & Schwartz, 2024).

The Neonatal Intensive Care Unit (NICU) is a specialized medical facility designed to provide intensive care for newborns, particularly those born prematurely or with serious medical conditions. The NICU is equipped with advanced medical technology and staffed by a multidisciplinary team of highly trained healthcare professionals specializing in neonatal care, ensuring continuous 24-hour monitoring and treatment for these vulnerable infants. The care provided in the NICU includes respiratory support, nutritional management, infection control, and continuous monitoring of vital signs. In addition, the NICU offers a range of diagnostic and therapeutic interventions such as radiology, ultrasonography, and surgical procedures (Vassilios, 2023).

Given the critical role of quality care in the NICU in reducing infant mortality and complications, early detection of neuropsychiatric disorders such as delirium is an aspect that cannot be overlooked. Delirium in infants often goes unrecognized due to its subtle manifestations and overlap with other clinical conditions, despite its potential to significantly affect recovery and long-term neurodevelopmental outcomes. Several instruments, including the CAPD and SOS-PD, have been developed to assist healthcare providers in systematically detecting delirium. However, evidence regarding the diagnostic accuracy of these instruments in the infant population remains limited and varies across studies. Therefore, this study aims to systematically review the diagnostic accuracy, validity, and reliability of the CAPD and SOS-PD instruments in detecting delirium among infants admitted to the NICU. The findings of this review are expected to provide a scientific foundation for clinical nursing practice and support the implementation of more effective delirium screening to

enhance the safety and quality of care for infants in neonatal intensive care settings.

RESEARCH METHOD

This review was prospectively registered with the International Prospective Register of Systematic Reviews (PROSPERO; submitted May 30, 2025; ID: CRD420251064345). The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were followed, and items were reported using the PRISMA checklist (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow, & Moher, 2021). The literature search process for this systematic review was conducted using the PEO framework (Population: infants admitted to the pediatric intensive care unit; Exposure: the use of pediatric delirium assessment instruments CAPD and SOS-PD; Outcome: early detection of delirium sensitivity, specificity, accuracy, validity, and reliability; Study Design: diagnostic validation studies including prospective, observational, and multicenter designs). The clinical question guiding this review was: What are the sensitivity and specificity of the CAPD and SOS-PD instruments in the early detection of delirium among infants (aged 0–12 months) admitted to intensive care units.

The literature search was performed across several electronic databases published in the last ten years, including PubMed, Sage Journals, ProQuest, Taylor & Francis, ScienceDirect, Cochrane, and ClinicalKey. Applying Boolean operator, the keywords used in the search included: "Assessment" AND "(Cornell Assessment of Pediatric Delirium OR Sophia Observation Withdrawal Symptoms scale Pediatric Delirium scale (SOS-PD) scale)" AND "Validity OR Validation OR Reliability".

The study selection workflow was carried out in an organized manner using EndNote as the reference manager. All search outputs from the databases were exported and transferred into EndNote to streamline citation management. Duplicate entries were initially detected through the software's automatic tool and subsequently checked manually to ensure that all duplicates were fully eliminated.

Following deduplication, three independent reviewers (AN, SC and LTP) screened article titles and abstracts against the predefined inclusion and exclusion criteria. Studies considered potentially relevant were retrieved for full-text review to confirm

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eligibility. Any disagreements between the two reviewers were resolved through discussion, and when consensus could not be reached, a third reviewer (MHH) provided the final decision. The data extraction table summarizes studies on the diagnostic accuracy of CAPD and SOS-PD in infants to adolescents, including authors, year, location, study objectives, sample size, age range, instruments, methods, and key outcomes such as sensitivity and specificity. The table highlights the effectiveness of both tools in detecting delirium in pediatric populations.

This review included observational studies that evaluated the accuracy of delirium screening tools (CAPD and SOS-PD) based on their sensitivity and specificity values when compared with established diagnostic standards, such as various editions of the diagnostic and statistical manual of mental disorders (DSM) or the International Classification of Diseases (ICD), as well as clinical observations applicable to the infant population. Studies published within the last ten years and involving participants aged 0 months to 18 years were included, as no published studies to date have specifically focused on validating delirium assessment instruments in the infant population. Language selection was limited to English, and only cohort studies were included. The exclusion criteria comprised adult populations, articles without full-text access, systematic reviews, and duplicate records. Titles and abstracts were screened to remove irrelevant studies. After eligible articles were identified, quality appraisal was conducted using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) tool. The included studies were then analyzed, revealing heterogeneity across their findings. The QUADAS-2 is a tool used to assess the methodological quality and risk of bias in diagnostic studies included in a systematic review or meta-analysis. It comprises four main domains patient selection, index test, reference standard, and flow and

timing and also evaluates certain aspects of applicability concerns (National Institute for Health and Care Excellence, 2025; Whiting, Rutjes, Westwood, Mallett, Deeks, & Reitsma, 2011).

The Cornell Assessment of Pediatric Delirium (CAPD) is an instrument designed to detect delirium in children across a wide range of ages and developmental stages in various hospital settings (Bergus et al., 2024). CAPD can be used to assess delirium in neonates, infants, and children up to 21 years of age, including those with developmental delays. Using the diagnosis of delirium by a child psychiatrist based on the DSM-IV criteria as the reference standard, the CAPD demonstrated a sensitivity of 94.1% and a specificity of 79.2% (Daoud, Duff, & Joffe, 2014). The tool consists of eight items, each rated on a 0–4 scale, with responses ranging from “never” to “always.” The total score ranges from 0 to 32, with a CAPD score of 9 or higher indicating the presence of delirium. Patients scoring ≥ 9 are categorized as having *delirium present*, while those with scores below 9 are classified as *delirium absent*. Anchor points are available to guide CAPD scoring for children under two years of age (Uyar, Kutlu, Akçay, Dinç, Onat, Koçkuzu, & Traube, 2025).

The Sophia Observation Withdrawal Symptoms–Pediatric Delirium (SOS-PD) scale is an observational tool designed to detect both delirium and withdrawal symptoms in children admitted to intensive care units. This instrument assesses changes in consciousness, attention, behavior, and physical symptoms such as tremors and excessive sweating. The strength of the SOS-PD lies in its ability to distinguish delirium from withdrawal symptoms, which often present with overlapping features, thereby enabling more timely and appropriate interventions. The methodological quality of the included studies was evaluated using the QUADAS-2 tool (Iodice, Raggi, Benegni, Garisto, Iacoella, Marinari, & Ricci, 2025).

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RESEARCH RESULTS

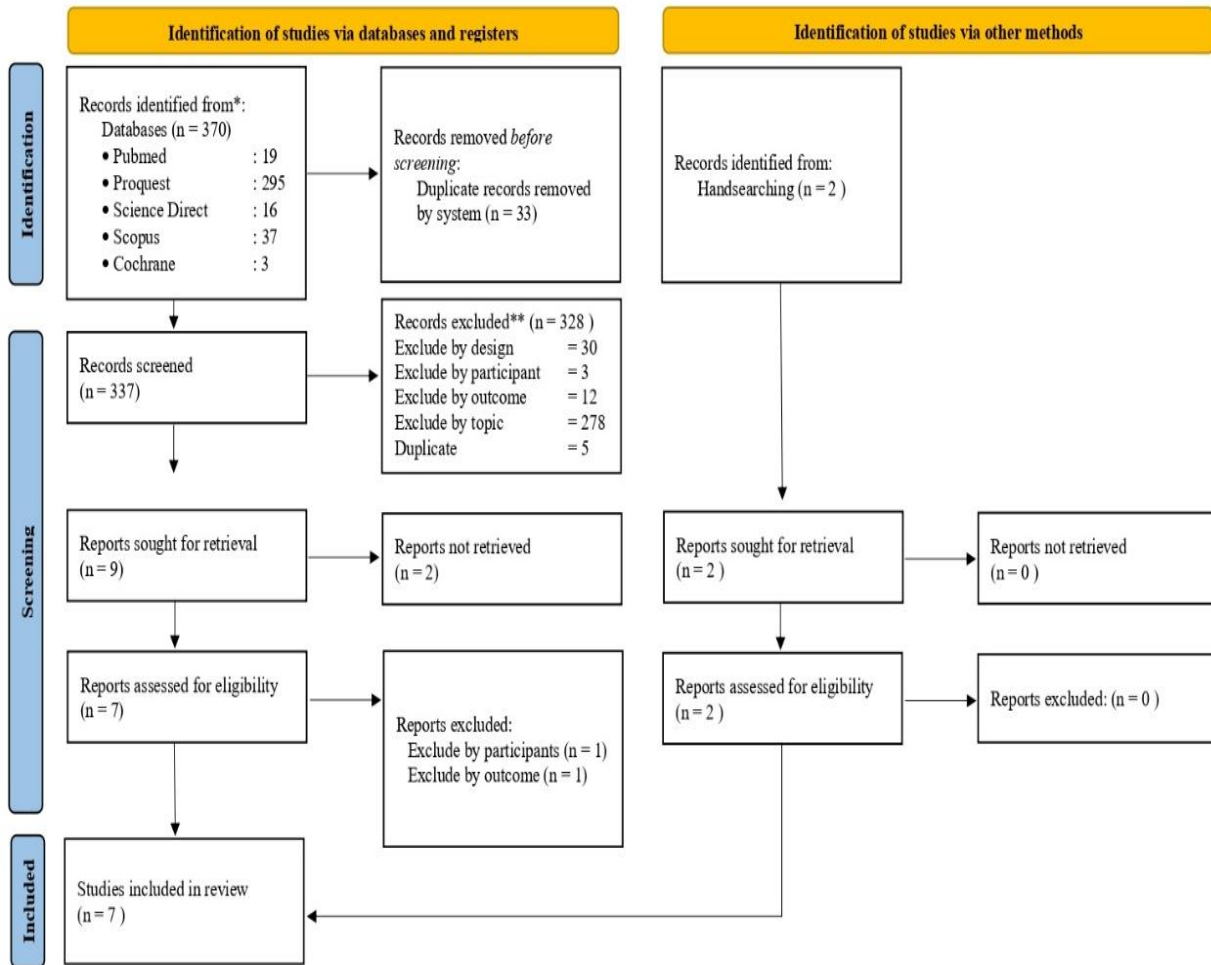


Figure. 1 PRISMA Flow Chart

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Table 1. Characteristics of the Studies Included in the Investigation

(Authors, Years) (Country)	Purpose	Sample	Age	Instrument	Method	Outcomes
(Hong et al., 2021) (China)	To validate the diagnostic accuracy of the CAPD in pediatric surgical patients.	N = 170	1m - 18y	CAPD	Prospective validation study	Sensitivity 87% (95 % CI: 65.3 % - 96.6 %) Specificity 98% (95 % CI: 93.7 % - 99.5 %)
(Hoshino et al., 2020) (Japan)	To assess the validity and reliability of the Japanese translation of the CAPD.	N = 41	0 – 13y	CAPD	Prospective double-blinded observational cohort study	Sensitivity 90% (95% CI: 79 - 97%), Specificity 88% (95% CI: 75 - 96%),
(Ista et al., 2018a) (Netherlands)	To evaluate the measurement properties of the PD component of the SOS-PD in critically ill children.	N = 146	3m – 16y	SOS-PD	Prospective, observational, repeated-measures study design	Sensitivity 96.8% (95% CI: 80.4 - 99.5%) Specificity 92.0% (95% CI: 59.7 - 98.9%).
(Ista et al., 2018b) (Netherlands)	To determine construct validity, criterion validity, and interrater reliability of the PD component of SOS-PD when used by nurses.	N = 485	3m – 18y	SOS-PD	Multicenter prospective observational study	Sensitivity of 92.3% and specificity of 96.5%
(Paterson et al., 2021) (Australia)	To assess the accuracy of various delirium screening tools against DSM-5 diagnosis and identify patient factors affecting their validity.	N = 119	6m - 17y	CAP-D, the psCAM-ICU, and the pCAM-ICU	Prospective, observational study	CAP-D Sensitivity 94.1% (84.0-99.0), Specificity 79.2% (74.0 - 85.0).

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(Authors, Years) (Country)	Purpose	Sample	Age	Instrument	Method	Outcomes
						psCAM-ICU Sensitivity 78.0% (75.0 - 80.0) Specificity 86.0% (84.0 - 88.0) psCAM-ICU Sensitivity 78.0% (40.0 - 97.0) Specificity 98.0% (91.0 - 99.9)
(Stenkjaer et al., 2024) (Denmark)	To validate the PD component of SOS-PD by comparing psychiatrist and nurse assessments, and estimate delirium prevalence in critically ill children in Denmark.	N = 141	3 m – 18 y	SOS-PD	Prospective observational study	Sensitivity 83.3% (95% CI: 65.3 - 94.4) Specificity 96.4% (95% CI: 91.0 - 99.0)
(Uyar et al., 2025) (Turkey)	To translate and culturally adapt the CAPD into Turkish and analyze its validity and reliability; secondarily, to evaluate its screening performance across developmental and age subgroups.	N = 76	0 – 18y	CAPD	Validation study	Sensitivity: 100% Specificity: 95%

Note: the Cornell Assessment of Pediatric Delirium (CAPD); the Sophia Observation withdrawal Symptoms–Pediatric Delirium (SOS-PD) scale; years (y); month (m); Preschool Confusion Assessment Method for the Intensive Care Unit (psCAM-ICU); Pediatric Confusion Assessment Method for the Intensive Care Unit (pCAM-ICU); Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5); Pediatric Delirium (PD).

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Table 2. QUADAS-2 Risk of Bias Assessment

Study	Risk of bias			
	Patient selection	Index test	Reference standard	Flow and timing
CAPD				
(Hong et al., 2021)	Low	Unclear	Low	Low
(Hoshino et al., 2020)	Low	Unclear	Low	Low
(Paterson et al., 2021)	Low	Low	Low	Low
(Uyar et al., 2025)	Low	Low	Low	Low
SOS-PD				
(Stenkjaer et al., 2024)	Low	Unclear	Low	Low
(Ista et al., 2018a)	Low	High	High	Low
(Ista et al., 2018b)	Low	Low	Low	Low

Table 2 shows that the methodological quality of the included studies was generally high, with most showing low risk of bias in patient selection due to prospective designs and consecutive enrollment. Two studies—the Danish CAPD validation and a nurse reliability study—did not use a reference standard such as DSM-5, limiting their evaluation to reliability rather than diagnostic accuracy. Bias in the index test domain was largely low, as blinded interpretations and predefined cutoff scores were commonly applied, though the Danish CAPD study reported cutoff use unclearly. Studies employing psychiatric diagnostic references (DSM-5 or VADIC) demonstrated low risk of bias in the reference standard domain through appropriate gold standards and blinded assessments. Flow and timing bias was also minimal, with short intervals (<24 hours) between index tests and reference standards and full inclusion of patients in analyses. Overall, applicability across study populations, index tests, and reference standards was judged to be strong.

DISCUSSION

This systematic review summarizes the findings of seven validation studies on pediatric delirium assessment instruments used in intensive care settings (NICU/PICU), with a particular focus on infants and young children. The instruments examined include the SOS-PD and CAPD, along with their linguistically and culturally adapted versions in Chinese, Japanese, and Turkish.

All studies aimed to detect delirium early and accurately, including in infants under two years of age.

Both CAPD and SOS-PD demonstrated high diagnostic accuracy when compared with psychiatric diagnosis as the gold standard. A multicenter study on the SOS-PD reported a sensitivity of 92.3% and a specificity of 96.5%, with excellent interrater reliability (ICC = 0.99). The Japanese and Chinese versions of the CAPD showed AUC values of ≥ 0.91 , with sensitivity and specificity exceeding 88%. Even the Turkish version of the CAPD achieved sensitivity and specificity of up to 100% and 98%, respectively, at a cutoff score of 11. However, most studies also noted that delirium symptoms often overlapped with those of IWS (Simm, Haase, Ritthaler, Engel, Nordmeyer, & Neunhoffer, 2025). This overlap is particularly evident in patients receiving long-term opioid or sedative therapy. It presents a diagnostic challenge, as symptoms such as agitation, sleep disturbances, and altered levels of consciousness are common to both conditions and are often difficult to distinguish. The SOS-PD was specifically designed to address this overlap by integrating the symptoms of IWS and delirium into a single screening instrument.

These instruments and their various adaptations have been applied in diverse clinical contexts: the Chinese version of the CAPD was validated among postoperative surgical patients, while the Japanese and Turkish versions were culturally and linguistically adapted for their respective local populations (Hoshino, Matsuishi, Enomoto, Shimojo, Kido, Matsuzaki, & Inoue, 2020; Uyar et al., 2025). The validation of the SOS-PD was conducted in Europe across various general and surgical intensive care units, with the Danish version demonstrating results

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consistent with those of the Dutch version (Ista et al., 2018a; Ista, et al., 2018b; Stenkjaer et al., 2024).

Parental involvement in assessing the child's behavior also constitutes an important element, particularly in the SOS-PD, which incorporates parents' evaluations of their child's behavior as a key indicator (Ista, et al., 2018b). This reinforces the family-centered care approach, which is essential in the context of pediatric intensive care.

The findings from these studies collectively support the systematic integration of validated delirium assessment tools into routine nursing practice. These instruments are not only applicable in PICUs but can also be implemented in NICUs. The effectiveness of implementation is supported by nurse training, interdisciplinary collaboration, and the establishment of clear follow-up protocols (Karmarkar, Speziale, & Jenkins, 2024). Nurses, as frontline healthcare providers, can utilize the CAPD or SOS-PD to detect delirium early and prevent long-term consequences such as developmental impairments in the child's neurological system. The routine application of these instruments is expected to enhance patient safety, improve team effectiveness, and promote a more evidence-based nursing practice.

This review, however, has several limitations. First, variations in study design and population characteristics make direct comparisons challenging. Although all studies included infants, the number of infants assessed and subgroup analyses focusing specifically on this population remain limited. Second, some studies involved relatively small infant samples, which may limit the generalizability of diagnostic accuracy estimates for the broader infant population. Third, cultural and linguistic differences may have influenced the outcomes of instrument adaptation, as seen in the Japanese and Chinese versions. Finally, since all tools are based on behavioral observation, assessment can be difficult in critically ill or heavily sedated infants, as symptoms may be less apparent.

CONCLUSION

The CAPD and SOS-PD demonstrate good validity, reliability, and diagnostic performance for pediatric delirium screening across diverse clinical settings. Available evidence suggests that these instruments may be applicable to infants admitted to the NICU; however, most included studies involved broad pediatric age ranges, and data exclusively

focusing on infants under one year of age remain limited. Therefore, while the findings support the potential integration of these tools into neonatal care practice, further research specifically targeting infant populations particularly neonates is warranted to strengthen the evidence base.

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